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THE LOW-MASS YOUNG STELLAR POPULATION IN ORION OB1

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RESUMEN

Presentamos resultados recientes de nuestro sondeo de variabilidad en la Asociación OB1 de Orión. En un área de ~ 25 grados cuadrados hemos develado nuevas poblaciones de estrellas jóvenes de baja masa, en medios ambientes diversos y abarcando edades desde 1-2 Maños en Ori OB 1b hasta aproximadamente 10 Maños en Ori OB 1a. La carencia de emisión intensa en Hα y de excesos en el cercano IR en las estrellas jóvenes de Ori OB 1a, sugiriendo que el acrecimiento de detiene y los discos se disipan en la mayoría de las estrellas tipo solar en cuestión de unos Maños, probablemente debido al inicio de la formación de planetas.
La ausencia de gas y polvo en Ori OB 1a es consistente con la idea que la formación estelar es un proceso rápido, en el que las nubes moleculares se disipan en unos pocos Maños después de formadas las primeras estrellas.

ABSTRACT

We present recent results from our ongoing large scale variability survey of the Orion OB1 Association. In an area of ~ 25 square degrees we have unveiled new populations of low-mass young stars over a range of environments, and ages from 1-2 Myr in Ori OB 1b to roughly 10 Myr in Ori OB 1a. There is a lack of strong Hα emission and near-IR excesses in the young stars of Ori OB 1a, suggesting that accretion stops and disks dissipate for most solar type stars in a few Myr, probably caused by of the onset of planet formation.
The absence of dust and gas in Ori OB 1a is consistent with the picture of star formation as a rapid process, in which molecular clouds dissipate in just a few Myr after the first stars are born.

Key Words: **STARS: FORMATION, LOW-MASS, PRE-MAIN SEQUENCE – SURVEYS**

1. INTRODUCTION

During the last few years our understanding of the formation of low-mass stars and planets has undergone major advances. But still little is known about these processes in in the vast areas spanned by nearby OB associations like Orion OB1, were thousands of young, low-mass ($\lesssim 1 M_\odot$) stars are expected to exist but remain undetected.

To address this problem, we are carrying out a long-term optical variability survey spanning $\sim 120\ deg^2$ in the Orion OB1 Association ($d \sim 400$ pc), to find, map, and study large numbers of widely-spread, low mass ($\lesssim 1 M_\odot$) stars with ages $\lesssim 10$ Myr. The survey area (Figure 1) includes young regions of star formation like the ONC ($\lesssim 1$ Myr), the Ori 1b sub-association (the belt region, ~ 2 Myr; Warren & Hesser [1977]; Brown et al. [1994]), and older regions devoid of molecular gas like the Ori 1a sub-association (~ 11 Myr old).

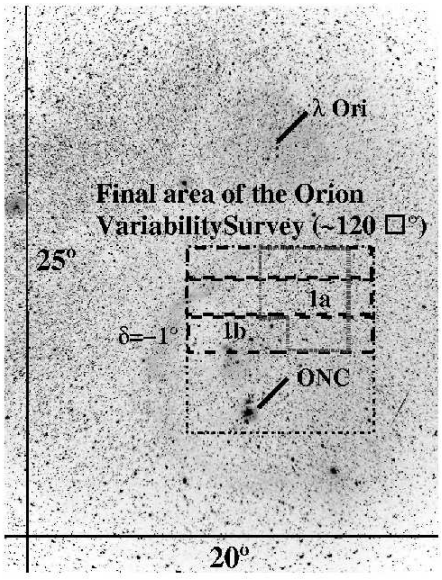

Fig. 1. Image of Orion showing the total survey area of 120 deg^2 (large dashed-lined box). The initial strip at $\delta = -1^o$, passing over the three Orion belt stars (Ori 1b) and part of Ori 1a is indicated. Two addditional strips covering the northern part of our survey have also been completed. The Orion Nebula Cluster and the bubble around the star λ Orionis are clearly seen.

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2. THE VARIABILITY SURVEY: INITIAL RESULTS

The multiband (BVRIHα), multi-epoch, survey is being carried out using an 8k x 8k pixel CCD Mosaic Camera (Baltay et al. 2002) installed on the 1.0/1.5m Schmidt telescope at The National Astronomical Observatory of Venezuela ($8°47'$ N, 3610 m elevation). The camera is optimized for drift-scanning, generating a continuous 2.3° wide strip of the sky at a rate of 34.5 $deg^2/hr/filter$, down to $V_{lim} = 19.7$ ($S/N = 10$). We identify variable stars using a χ^2 test at a 99.99% confidence level.

Among the bright objects ($V \lesssim 16$) in a strip centered at $\delta = -1^o$ (Figure 1), we selected candidate variable stars located above the zero age main sequence (ZAMS) in a V vs. $V - I$ diagram. Followup spectroscopy was obtained using the FAST spectrograph on the 1.5m telescope of the Smithsonian Astrophysical Observatory at Mt. Hopkins, Arizona, with a spectral resolution of 6.5Å over the range 4000 - 7000Å. Of 350 candidates, 180 were confirmed as low mass pre-main sequence stars (T Tauri stars - TTS), based on the presence of emission lines such as Hα and the absorption line Li I 6707Å (an indicator of youth in late type stars [Briceño et al. 1997, 1999]). The newly identified TTS have spectral types K3 - M2 ($M_* \sim 0.9 - 0.6\ M_\odot$).

Figure 2 shows color-magnitude diagrams for stars in Ori 1a and 1b. The data for each star are median values determined from the multiple observations of each object. It is apparent that stars in 1a are older than stars in 1b. Stars in 1b seem to fall between the isochrones corresponding to 1 - 3 Myr, while stars in 1a fall between 3 and 30 Myr.

Using the near-IR JHK data for the new TTS, obtained from the second release of the 2 Micron All Sky Survey (2MASS), we find that all stars in Ori 1a are within the region expected for purely stellar emission; in contrast, many stars in 1b have large $H-K$ colors indicative of excess emission from a hot inner dusty disk, and exhibit the strong Hα emission (W[Hα] $\gtrsim 10\mathring{A}$) associated with accretion from a circumstellar disk onto the central star. The lack of Hα emission in Ori 1a stars indicates that protoplanetary disk accretion stops for almost all solar-type stars; the absence of near-IR excesses shows that significant inner disk dissipation ocurrs in a few Myr, possibly caused by coagulation of the dust particles into larger bodies like planetesimals/planets.

Our results have important implications for the star forming history of the region. We see a well-defined older association, Ori 1a, resembling a fossil version of the younger Ori 1b located next to it, a plausible scenario for triggered or sequential star formation. Also, the absence of molecular gas in Ori 1a supports suggestions that large molecular cloud complexes can form stars and disperse in only a few Myr (Ballesteros et al. 1999).

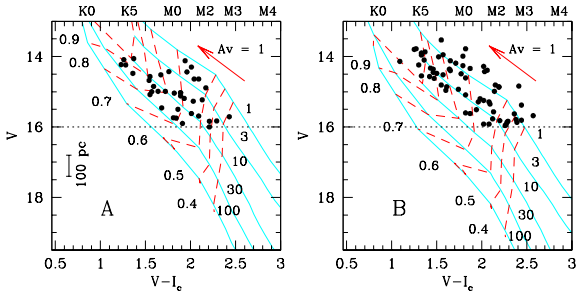

Fig. 2. V vs. $(V - I_c)$ diagram for the brighter new TTS in Ori 1a (A; d=330 pc) and Ori 1b (B; d=460 pc). Isochrones (solid lines) for ages 1 to 100 Myr and evolutionary tracks (dashed lines) for masses 0.4 to 0.9 $M_\odot$ are indicated (Baraffe et al. 1998). The shifts due to 1 magnitude of de-reddening (arrow) and to a distance change of 100 pc (left vertical bar) are also indicated. The dotted lines show the V=16 limit of FAST spectroscopy.

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